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Other Applications of Thermal Cameras and Developing Handle Temperature Camera

Doan Ngoc Phuong[1] & Nguyen Thi Phuong Thanh[2*]

[1,2]*TNU - University of Information and Communication Technology, Thai Nguyen City, Vietnam.*
*Corresponding author email: ntpthanh@ictu.edu.vn**

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ABSTRACT

Thermal cameras are useful devices, Today, advanced thermal imaging devices with high sensitivity are being developed and used, especially in the medical field (Lahiri et al., 2012). Products from the research results of the author group towards compact size, easy to handle, convenient to carry, low cost of implementation, monitoring range in the measuring area of the sensor eye up to 7 meters, the monitoring temperature zone can be limited, the color displayed is equivalent to the temperature zone, and the resolution of the thermal pixels can also be adjusted simply through the buttons.

In order to expand the application range of research products, improve accuracy, reliability, increase resolution, etc., it is possible to use more measuring sensor eyes, use wireless communication networks, accurate image recognition and processing algorithms, large display screen to facilitate monitoring more clearly.

Keywords: *Thermal camera, Handheld thermal camera, Temperature, Infrared heat, Non-contact body temperature measurement.*

1. Introduction

The outstanding ability of infrared thermal cameras is to capture images and temperatures in areas of light that are invisible to the human eye, so its applications are diverse, in many fields such as security monitoring, fire detection, medical, long-distance non-contact body temperature measurement, maintenance, maintenance, inspection, repair, warning of thermomechanical, electrical, electronic equipment, etc. A thermal infrared camera detects infrared waves emitted by an object and converts them into electronic signals and creates thermal images. While the thermal images are defined as thermograms, the name of this technique is defined as infrared thermography (IRT) (Usamentiaga et al., 2014).

Application of thermal cameras in industrial maintenance

Thermal cameras also play a particularly important role in the maintenance of industrial plants. Check, detect and predict in time to prevent breakdowns of areas, production equipment, and electrical systems that emit heat in the factory. In addition, mechanical equipment in the factory can also experience problems that increase temperature due to high friction or incorrect operation.

In the field of product research and development, thermal imaging is used to check temperature emitting points (such as circuit boards). Nowadays, electronic technology develops more and more, leading to smaller and smaller circuit boards-thus increasing the heat dissipation challenges of circuit boards. Using a thermal camera helps monitor the heating and heat dissipation of the circuit board, thereby designing the most optimal circuit board.

Furthermore, the researchers also published many works on the applicability of thermal cameras such as: Calibration of low-resolution temperature images for human temperature monitoring applications, detection systems, etc. dynamic use of artificial intelligence based on thermal imaging provides a urine flow measurement to assess urinary tract severity, non-contact body temperature measurement in thermal imaging changing

environmental conditions using deep learning (Y. -C. Chen, J. -P. Su, C. -H. Tsai, M. -C. Chen, W. -J. Chang and W. -J. Wu,, 2022), real-time power system fault detection based on thermal imaging (C. Song and S. Lee, 2022), hand gesture classification using thermal imaging and neural networks.

The authors have researched and developed a compact device that allows temperature monitoring and acquisition of pixels reflecting the corresponding heat region.

Research Questions

Question 1: What re system design and experimental results?

Question 2: What are other Applications of thermal cameras?

2. Literature Review

Manullang et al (2021) pointed that Non-contact physiological measurements based on image sensors have developed rapidly in recent years. Among them, thermal cameras have the advantage of measuring temperature in the environment without light and have potential to develop physiological measurement applications. Various studies have used thermal camera to measure the physiological signals such as respiratory rate, heart rate, and body temperature.

Based on existing studies, there has been a change in medical services since the outbreak of SARS-CoV-2 19. Contactless services have been implemented during SARS-CoV-2 19, and will become commonplace even after the pandemic. Several developments such as measuring RR and HR using the non-contact method with radar sensors, blood volume pulse and vasomotion measurements (McDuff et al, 2020), using radio frequency, and the Doppler effect to monitor vital body objects have been tested and researched (Hall et al, 2017).

Next Purnama et al (2020) pointed Thermal camera measure 36°C, 37°C, 38°C object temperature and gives accuracy respectively 99.38%, 99.39% 99.41%. Thermal camera not only gives high accuracy but also high precision. The precision for same temperature respectively 35.01 ± 0.63 when measure 36°C object temperature, 36.55 ± 0.26 when measure 37°C object temperature, and 37.27 ± 0.49 when measure 38°C object temperature. This result is satisfied and good enough to examine human body temperature.

Kadirsoy et al (2021) mentioned studied the determination of the general health status of people in hazardous CBRN zones via a thermal camera. It is obvious that there is a continuous need to obtain information about the scene of the incident such as the alive, sick, and injured people in the situation of hard-to-reach and highly hazardous CBRN areas. In addition, autonomous analysis techniques were studied on the obtained images. In this study, it is focused on the determination of health status according to body temperature measurement, which is one of the vital signs, by the advantages of applying to more than one person without contact provided by thermal cameras integrated into a UAV.

Every object above zero temperature emits a specific infrared wave. The wavelength and frequency of the emitted infrared radiation change in direct proportion with object temperature. Although this wide range of radiation, the infrared waves emitted by a normal person are in a very narrow range of 8 -12 μm. So, thermal images can provide distinctive data (Psokoski, 2000; Usamentiaga et al., 2014).

3. Methodology

This is an experimental model, and authors also test the products and results are real examples in Vietnam.

This paper uses mainly description, qualitative analysis and analytical and synthesis methods. Authors also use observations and experiences, design and practical experiments.

4. Main findings

4.1. System design

4.1.1. Hardware design

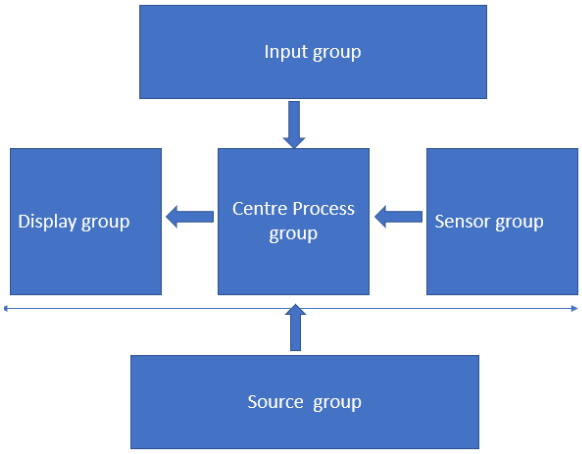


Fig.1. Block diagram of handheld mini thermal camera system

Input block: A switch as shown in Figure 2 (a) to turn on and off the power supply with contact resistance ≤ 20 MΩ, insulation ≥ 100 MΩ and buttons in Figure 2 (b) to install the device, is a PBS type -110, NC, capacity 250V1A AC, resistance 100 M.

(a) (b)

Fig.2. (a) Power switch, (b) Push button

4.1.2. Software program design

The algorithmically designed thermal imaging camera device is an infinitely repeated program, consisting of the following steps:

Step 1: Start the program to declare the libraries: SPI, Wire, AMG8833, I2C.

Step 2: Declare preprocessor: create pin connections between Arduino nano with peripherals: buttons, screen, sensor AMG88, set the minimum temperature threshold tmin and the highest tmax to give notice, defines the color codes to be displayed on the oled.

Step 3: Check the condition of pixel value setting (via button 1), if:

+ True: Increase pixels using button 1, decrease pixels using button 2.

+ Wrong: Go to Step 4.

Step 4: Continuity of data from infrared thermal sensor AMG8833, and check condition:

+ If the measured temperature (t) is in the range tmin ≤ t ≤ tmax, the Normal information is displayed with the corresponding color codes for the heat zones.

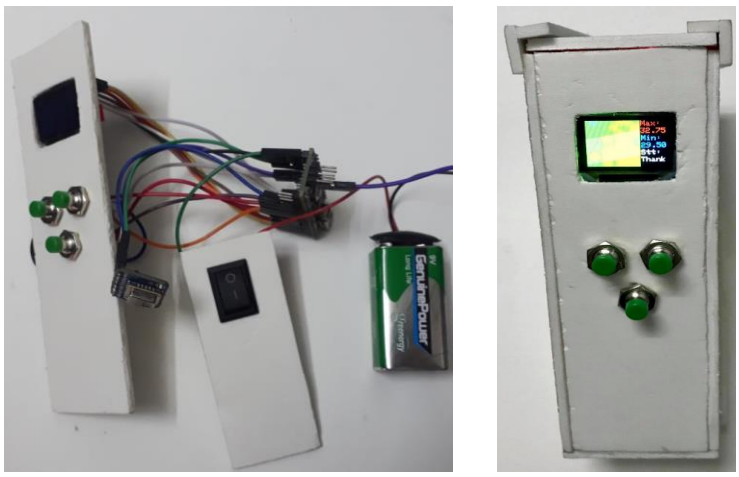
+ If the measured temperature is t < tmin, the Low information is displayed with the corresponding color codes for the heat zones.

+ If the measured temperature t > tmax, display High information with color codes corresponding to the heat zones.

Step 5: Go back to Step 3.

5. Experimental Results

When the power switch is turned on, the display screen will pixel, color code and corresponding temperature within the monitoring range of the AMG8833 sensor receiver within a range of less than 7m onto a 0.95 inch screen. When you need to set the pixels, increase or decrease, press the Menu button and the Up and Down buttons respectively. Depending on the temperature in the area received from the sensor, the value goes up, the message and the corresponding color areas go up Oled.



(a) (b)

Fig.3. (a) Construction and connection of electronic components,

(b) Finished handheld mini thermal camera

5.1. Discussing other Applications of thermal cameras

Thermal cameras, also known as thermal cameras or infrared cameras, use infrared radiations to capture thermal areas, save and display them as color palettes corresponding to temperature levels.

Thermal camera has the ability to detect and check for errors.

In addition to being used in security systems, thermal cameras are also used to detect and check errors. Precisely as:

This device allows monitoring and detecting sick travelers or pathogens at airports and border gates.

In the maintenance of mechanical and electrical equipment: This device allows users to easily detect the location and thermal overload of the part, so that the user can maintain it in time and provide the best solutions.

In construction works: This device can help in detecting gas leaks, water infiltration, water leaks through the most accurate temperature indication. This is also considered as non-destructive testing equipment.

In some other fields, this device also has specific applications such as: chemical photography, research and development of new products, pollution source detection, disease diagnosis, etc.

Also, Applications of indoor thermal cameras:

- Adjust the efficiency of the ventilation system.

- Adjust the most suitable heating system.

- Check the electrical system, ensure electrical safety, overheating problems.

- Check the quality of the air conditioner.

- Check the insulation effect of the thermal bridge window.

- Detect moisture and mold.

Beside, Manullang et al (2021) specified that several suggestions and prospects such as healthcare applications, machine learning, multi-parameter, and image fusion, have been proposed to improve the physiological measurement of thermal camera in the future.

(Source: author synthesis)

Fig.4. Camera (thermal)

Moreover, Thermal cameras have the advantages of operating in an environment without light and not being affected by changes in light. There are existing studies illustrating that thermal camera can be used to monitor respiratory rate (RR), heart rate (HR), and body temperature, while other studies found its use in breast cancer diagnosis, evaluating physical condition, stress level, as well as the neonates' health condition (Topalidou et al, 2019), sleep posture (Mohammadi et al, 2021).

Another technology is the smartphones with thermal camera features, as well as thermal cameras with the ability to connect to phones with simple interfaces (Rodin at al., 2018). Although thermal cameras are a very efficient technology on their own, they can be used in combination with various robotic systems according to the characteristics of the research field today (Lock and Amon, 2008).

6. Conclusion

Thermal cameras have below advantages: compact design, low cost (saving), easy to bring, many applications in Non-contact body temperature measurement, maintenance, maintenance, quality inspection and electrical equipment phone, etc. In order to expand the application range of research products, improve accuracy, reliability,

increase resolution, etc., it is possible to use more measuring sensor eyes, use wireless communication networks, accurate image recognition and processing algorithms, large display screen to facilitate monitoring more clearly.

7. Research limitation

Study can expand for other practical applications with more experiments.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent for publication

Authors declare that they consented for the publication of this research work.

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